

**WHAT IS CLAIMED IS:**

- 1        1.    A system for performing the pseudo-spectral time-domain (PSTD) method on data,
- 2        comprising:
  - 3                a forward fast Fourier transform (FFT) unit calculating a forward fast Fourier
  - 4                transform (FFT) from the data;
  - 5                a complex multiplication unit receiving the FFT-processed data and calculating a
  - 6                spatial derivative in the frequency domain from the FFT-processed data;
  - 7                an inverse fast Fourier transform (IFFT) unit converting the spatial derivative in the
  - 8                frequency domain from the complex multiplication unit into the time domain; and
  - 9                a computation engine solving a PSTD equation based upon the spatial derivative in
  - 10              the time domain received from the IFFT unit.

- 1        2.    A system as recited in claim 1, wherein the PSTD equation takes the form:

$$E_{ab} = AE_{ab} + B \frac{\partial H_c}{\partial b} + CE_{ab}^{inc},$$

- 3        where  $a$ ,  $b$ , and  $c$  are directions (x, y, and z),  $A$ ,  $B$ , and  $C$  are coefficients based on material
- 4        properties of a medium, and  $E_{ab}^{inc}$  is the incident field associated with the node.

- 1        3.    A system as recited in claim 1, wherein as the FFT is being calculated, primary fields,
- 2        incident fields, and coefficients are being fetched by the system.

- 1        4.    A system as recited in claim 1, wherein the FFT and IFFT units are provided inside a
- 2        field-programmable gate array (FPGA).

1           5.       A system as recited in claim 4, wherein the FFT and IFFT calculations are performed  
2        by a digital signal processing (DSP) chip.

1           6.       A system for performing the pseudo-spectral time-domain (PSTD) method on data,  
2        comprising:

3                a plurality of forward fast Fourier transform (FFT) units, each FFT unit calculating a  
4        forward fast Fourier transform (FFT) from the data;

5                a plurality of complex multiplication units, each complex multiplication unit  
6        receiving the FFT-processed data from a corresponding FFT unit and calculating a spatial derivative  
7        in the frequency domain from the FFT-processed data;

8                a plurality of inverse fast Fourier transform (IFFT) units, each IFFT unit converting  
9        the spatial derivative in the frequency domain from a corresponding complex multiplication unit into  
10      the time domain; and

11               a plurality of computation engines, each computation engine solving a PSTD equation  
12      based upon the spatial derivative in the time domain received from a corresponding IFFT unit.

1           7.       A system as recited in claim 6, wherein the PSTD equation takes the form:

$$E_{ab} = AE_{ab} + B \frac{\partial H_c}{\partial b} + CE_{ab}^{inc},$$

3        where  $a$ ,  $b$ , and  $c$  are directions (x, y, and z),  $A$ ,  $B$ , and  $C$  are coefficients based on material  
4        properties of a medium, and  $E_{ab}^{inc}$  is the incident field associated with the node.

1           8.       A system as recited in claim 6, wherein as the FFT is being calculated, primary fields,  
2        incident fields, and coefficients are being fetched by the system.

1           9.       A system as recited in claim 6, wherein the plurality of FFT and IFFT units are  
2       provided inside a field-programmable gate array (FPGA).

1           10.      A system as recited in claim 9, wherein the FFT and IFFT calculations are performed  
2       by a digital signal processing (DSP) chip.

1           11.      A computer hardware configuration for performing the pseudo-spectral time-domain  
2       (PSTD) method on data, comprising:

3                a forward fast Fourier transform (FFT) unit calculating a forward fast Fourier  
4       transform (FFT) from the data;

5                a complex multiplication unit receiving the FFT-processed data and calculating a  
6       spatial derivative in the frequency domain from the FFT-processed data;

7                an inverse fast Fourier transform (IFFT) unit converting the spatial derivative in the  
8       frequency domain from the complex multiplication unit into the time domain; and

9                a computation engine solving a PSTD equation based upon the spatial derivative in  
10      the time domain received from the IFFT unit.

1           12.      A computer hardware configuration as recited in claim 11, wherein the PSTD  
2       equation takes the form:

$$3                E_{ab} = AE_{ab} + B \frac{\partial H_c}{\partial b} + CE_{ab}^{inc},$$

4       where  $a$ ,  $b$ , and  $c$  are directions (x, y, and z),  $A$ ,  $B$ , and  $C$  are coefficients based on material  
5       properties of a medium, and  $E_{ab}^{inc}$  is the incident field associated with the node.

1           13. A computer hardware configuration as recited in claim 11, wherein as the FFT is

2 being calculated, primary fields, incident fields, and coefficients are being fetched by the system.

1           14. A computer hardware configuration as recited in claim 11, wherein the FFT and IFFT

2 units are provided inside a field-programmable gate array (FPGA).

1           15. A computer hardware configuration as recited in claim 14, wherein the FFT and IFFT

2 calculations are performed by a digital signal processing (DSP) chip.

1           16. A computer hardware configuration for performing the pseudo-spectral time-domain

2 (PSTD) method on data, comprising:

3           a plurality of forward fast Fourier transform (FFT) units, each FFT unit calculating a

4 forward fast Fourier transform (FFT) from the data;

5           a plurality of complex multiplication units, each complex multiplication unit

6 receiving the FFT-processed data from a corresponding FFT unit and calculating a spatial derivative

7 in the frequency domain from the FFT-processed data;

8           a plurality of inverse fast Fourier transform (IFFT) units, each IFFT unit converting

9 the spatial derivative in the frequency domain from a corresponding complex multiplication unit into

10 the time domain; and

11           a plurality of computation engines, each computation engine solving a PSTD equation

12 based upon the spatial derivative in the time domain received from a corresponding IFFT unit.

1           17. A computer hardware configuration as recited in claim 16, wherein the PSTD

2 equation takes the form:

3           
$$E_{ab} = AE_{ab} + B \frac{\partial H_c}{\partial b} + CE_{ab}^{inc},$$

4 where  $a$ ,  $b$ , and  $c$  are directions (x, y, and z),  $A$ ,  $B$ , and  $C$  are coefficients based on material

5 properties of a medium, and  $E_{ab}^{inc}$  is the incident field associated with the node.

1           18. A computer hardware configuration as recited in claim 16, wherein as the FFT is

2 being calculated, primary fields, incident fields, and coefficients are being fetched by the system.

1           19. A computer hardware configuration as recited in claim 16, wherein the plurality of

2 FFT and IFFT units are provided inside a field-programmable gate array (FPGA).

1           20. A computer hardware configuration as recited in claim 19, wherein the FFT and IFFT

2 calculations are performed by a digital signal processing (DSP) chip.